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Red Tart Cherry Site Inventory

for Charlevoix & Emmet Counties, Michigan

U.S. Department of Agriculture
Soil Conservation Service
East Lansing, Michigan

CONTENTS

A FRUIT SITE INVENTORY

A method of identifying and mapping red tart cherry sites was developed in Northwestern Michigan. The basic procedure described here for cherry sites can be adapted to other geographic areas and for other fruit crops with exacting requirements of soil, topography and climate. The use of this inventory does not eliminate the need for on-site investigations.

Objective

The objective of the red tart cherry site inventory is to evaluate a parcel of land in a given location according to its capability to consistently produce cherry crops. Such an inventory is valuable for determining the location, extent and quality of available red tart cherry sites.

Areas with the favorable combination of soil and climate for producing red tart cherries are located and evaluated. This type of information is useful in many ways, one of which is protecting these rather limited areas from being despoiled by the pressures for other land uses.

Dependable red tart cherry sites are in demand for other uses. Generally high lying, they are choice locations for home building. Community planners need to recognize the value of these relatively scace sites, to set priorities on their use and to give protection, if necessary, to the environmental condition that makes these sites productive. Construction of a building complex or even the raised roadbed of a new highway built across a major air flowageway may change a good, frost-protected site to one that is unsatisfactory for production of red tart cherries.

The site inventory also may help prevent the planting of orchards on unfavorable sites. The grower, the processing industry and the community suffer as a result of fruit planted on marginal sites. The red tart cherry industry illustrates this problem. It has had a history of feast and famine for many years. The years of high production have usually resulted in low prices. Low production years resulted in higher prices. Generally, the high price years encouraged growers to plant new orchards, many on marginal sites. When these trees come into production, those on marginal sites bear only in years of favorable weather conditions. This increases the already fluctuating production - high in years of favorable weather, very low in others.

Processors and market outlets are dependent on a stable supply of cherries. The cherry processor cannot maintain plant capacity to handle peak production that occurs only 2 or 3 years out of 10. During surplus market conditions, prices drop to a level where neither grower nor processor can operate at a profit. In years of low production, only the favorable sites produce a good crop of cherries. Some growers have nothing to sell and the processor has equipment standing idle. The industry is always faced with the problem of furnishing a uniform annual supply in order to attract the consumer to purchase cherries and not a substitute fruit. It is difficult for an industry to maintain its position in the market place with such wide variations in production, caused in part by orchards planted on marginal sites.

A rating system has been developed as a way to inventory red tart cherry sites in order to meet the needs of the growers, processors, community planners and others.

Inventory's Information Can:

1. Assist the potential fruit grower in selecting a site for a profitable enterprise.

2. Assist the present fruit grower in reassessing present orchards and in planning future plantings.

3. Assist growers in relocating to a more favorable location or in obtaining a larger economic unit.

Other Uses:

1. Agriculture assessment - to delineate lands that should receive tax consideration if they are to be maintained in agricultural use.

2. Zoning commissions - to delineate potential fruit sites and plan for nonconflicting uses adjacent to fruit areas.

3. Planners of community services - to cause the least amount of fragmentation of ownership.

4. Comprehensive area wide planners - to establish basis for a stable industry.

5. Investors - to evaluate risks in capital investments pointed toward developing fruit producing areas with a favorable and stable base.

6. Tourists - fruit production increases and enhances the tourism and recreational potential of an area. Tourists are a by-product of the total fruit industry.

Agencies Or Groups That Might Use A Fruit Site Inventory Include:

1. Processing groups

2. Banks or credit organizations

3. Nurseries

4. Irrigation and other equipment suppliers

5. Fruit specialists

6. Agricultural research groups

7. Climatologists

8. Resort and recreation groups

9. Zoning and planning boards

10. Real estate sales organizations

RED TART CHERRY SITE INVENTORY

Field work completed October 1975 by: Charlevoix & Emmet Counties, Michigan

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Charlevoix and Emmet Counties are in the northwestern part of the lower peninsula of Michigan (figure 1). Emmet County has a total area of 461 square miles or 295,040 acres. Charlevoix County has a total area of 414 square miles or 264,960 acres. In 1970, Emmet County had a population of 18,331 and Charlevoix County a population of 16,541. The county seat of Emmet County is Petoskey located at the southeast end of Little Traverse Bay of Lake Michigan; the county seat of Charlevoix County is Charlevoix located at the mouth of Lake Charlevoix at Lake Michigan. Elevation in both counties ranges from 580 feet above sea level along Lake Michigan to 1,250 feet in the higher moraines. The major highways coming into the counties are: US-31, US-131, M-32 and M-75. The Penn Central Railroad and the Chesapeake & Ohio at present serve the counties. The Beaver Island Boat Company operates out of Charlevoix and provides access to Beaver Island and other offshore islands from the mainland. Lake Michigan borders both counties. Charlevoix County has about 25 miles of shoreline and Emmet County has about 65 miles. The counties are 260 miles northwest of Detroit, 180 miles north of Grand Rapids, 200 miles northwest of Lansing and extend to the Straits of Mackinac.

Figure 1 - Location of Charlevoix and Emmet Counties

Site Requirements for Red Tart Cherries - The Charlevoix and Emmet Counties' inventories were based on the site requirements of the Montmorency red tart cherry. This fruit occupies the most acreage and is economically the most important agricultural crop grown in the counties.

Following are factors which make a desirable red tart cherry site in Charlevoix and Emmet Counties:

Soil Factors - The most desirable soil is a well drained sandy loam that is well aerated and has a medium to high natural fertility. The soil must have a moderate available water capacity, a moderate to moderately rapid permeability and at least 48 inches of depth to permit unrestricted root penetration for good growth and anchorage. Soils having these characteristics will usually respond well to the proper management techniques for growing red tart cherries.

Physiographic Factors

Physiographic features of the site determine to a large extent the microclimate, which in turn, influences yield of cherries. Differences of soil, soil cover, elevation and exposure are responsible for microclimatic variations that are extremely important. The most desirable site would be one on which all affects of local climate are favorable for best production. Slope gradient should be 2 to 12% to permit ease of equipment use and other soil management practices, yet still provide adequate air drainage. Slope should be fairly uniform with well-defined water and air flowageways. The site should be located so that cold air from adjacent land does not drain over or onto it. Also, it is more desirable to have air drained into a cold air storage basin over water than into a cold air storage basin over land. Orchards should be planted above the principle spring freeze line[1/] of the cold air storage basin. Finally, the general exposure should permit the crop to take full advantage of sunshine yet not be exposed to damaging winds during pollination and fruit bearing.

Climatic Factors

The spring temperature should remain cool to retard fruit bud development and minimize danger of damage due to spring freezes. During the pollination-fertilization period of bloom, temperatures should exceed 50° F. in daytime for bee activity and should not drop below 28 to 30° F. for any period of time. The site should be as free of fog as possible. Warm sunny days without desiccating winds are important for good pollination and fruit set.

The lowest winter temperatures seldom, if ever, should get as low as -15 to -20° F. for tart cherries. An insulating cover of snow can provide for uniform soil temperature, but whether or not this is a significant factor in fruit production is not known. (Sunshine reflected from the snow cover may cause wide and rapid variations of temperature in tree trunks, resulting in tree damage which leads to reduced production. Management techniques can control this problem.)

The factors and weights given them for red tart cherry sites are shown on the Fruit Site Rating Sheet.

1/ See Appendix for definition

FRUIT SITE RATING SHEET

I. Soil Factors

	Rating Value	Actual Score
A. Texture: (1) Possible Score = (40)		
(Sands)	10	
Sandy (Loamy Sands)	20	
Coarse loamy	40	
Fine loamy	30	
Clayey	10	
Clayey (very fine)	5	
Organic	0	
B. Drainage: Possible Score = (40)		
Well drained	40	
Moderately well drained	30	
Somewhat poorly drained	20	
Poorly and very poorly drained	10	
C. Restrictions to Rooting: Possible Score = (20)		
No restrictions to 48 inches	20	
Coarse fragments within 48 inches	10	
Pans within 48 inches	5	

Total possible score = 100 I. Total Actual Score _____

II. Physiographic Factors

A. Slope: Possible Score = (35)	
2-12%	35
0-2%	30
12-18%	15
Over 18% (unsuitable for mechanical harvest)	10
B. Elevation above Principle Spring Freeze Line: Possible Score = (30)	
100 feet plus	30
50-100 feet	25
20-50 feet	20
Less than 20 feet	0
C. Air Drainage: Possible Score = (35)	
Uninterrupted airflow to major air storage basin	35
Minor obstruction to air flow to major air storage basin	25
Major obstruction to air flow to air storage basin	5

Total possible score = 100 II. Total Actual Score _____

(1) Refers to soil family texture as used in the Soil Classification System of the National Cooperative Soil Survey.

FRUIT SITE RATING SHEET - cont.

III. Climatic Factors

	Rating Value	Actual Score
A. Spring Temperatures: Possible Score = (70)		
Probability of damaging freeze or cold weather during fruit set during 10 year period.		
2 in 10	70	
3-4 in 10	40	
5-6 in 10	10	
B. Winter Temperatures: Possible Score = (30)		
Probability of extreme cold winter temperature during 10 year period.		
2 in 10	30	
3-4 in 10	5	
5-6 in 10	0	

Total Possible Score = 100 III. Total Actual Score _____

The occurrence of fog, wind and hail were not given individual ratings, however, they were included in the overall site evaluation.

Summary of Scores - Section I _____
Section II _____
Section III _____

Site Rating or Total Score _____

Interpretation of Fruit Site Ratings

Total Score	Map Color	Difficulty of Overcoming Limitations to Production
300-290	Green	Slight
285-225	Yellow	Moderate
220-170	Red	Severe
165 or less	No color	Very severe

Following on-site examination and scoring of each item in the rating sheet, the total score for a site is obtained by adding the sums of the rating scores for the soil, physiographic and climatic factors. This total is referred to as the Fruit Site Rating.

Map Preparation

Colors and symbols are used to identify and to delineate fruit sites. The ranges (interval) of fruit site ratings used in the red tart cherry site inventory in Charlevoix and Emmet Counties are shown with map colors and degree of limitation on the bottom of the Fruit Site Rating Sheet.

Explanation of Colors

GREEN - The areas colored green on the map are within the narrow range of 290 to 300. These represent the most desirable red tart cherry sites. The major soils are well drained, moderately coarse textured and have no restricted root zone within 48 inches of the surface. The slopes range ideally from 2 to 12 percent. The elevation above the principle spring freeze line is over 50 feet. Air flow is unimpeded or is blocked only by minor obstructions that can be easily removed. The probability of damaging freeze or cold weather during the time of fruit set is 2 years or less in 10 years. The probability of extreme cold winter temperatures is 2 years or less in 10 years. The soils, physiographic features and microclimate individually and collectively create few limitations to production.

YELLOW - Areas colored yellow on the map have a range of 225 to 285. They are good tart cherry producers, but need intensive management practices to overcome the moderate limitations to production. One to three of the following factors may cause the lowered site rating:

1. Moderately low available water capacity.

2. Moderately low natural fertility.

3. In some locations, a water table within 4 or 5 feet of the surface.

4. Slopes somewhat steeper than 12 percent.

5. Elevations less than 50 feet, but over 20 feet above the principle spring freeze line.

The probability of damaging freeze, cold weather or fog during blossom time or the probability of extremely low winter temperatures is not more than 3 to 4 years in 10 years.

Other features that may depress the rating are: areas needing random drainage, areas of nearly level land within dish-shaped terrain in which cold air is likely to stagnate, blockages that stop air movement of small areas that are adversely affected because of very coarse or fine textured soil inclusions. Symbols are used to indicate these features on the map.

RED - Areas colored red have a range from 170 to 220. The severe limitations are difficult to overcome by management. All limitations should be considered carefully before planning to plant these areas to red tart cherries.

Where small areas of this range occur within areas with fewer limitations, it may be feasible to consider corrective measures. One limiting factor of sufficient severity which cannot be corrected will suffice to rate a site between 170 to 220. Adverse characteristics are:

1. Low available water capacity.

2. Low natural fertility.

3. Moderately slow permeability.

4. Slopes that cause difficulty in efficient machinery operation.

5. Elevations near or at the principle spring freeze line with a probability of a freeze of 4 or 5 years in 10 years or extreme low temperature of 4 to 5 years in 10 years.

6. Major obstruction to air flow.

UNCOLORED - Areas having a rating of 165 or below are uncolored on the map. The limitations are so severe that these areas are not considered as red tart cherry sites.

The principle limiting factors are:

1. Poorly drained soils.

2. Extremely droughty, infertile soils.

3. Slopes that are too steep for orchard equipment operation.

4. Large areas having little or no air drainage.

5. Location below the principle spring freeze line with a frequency of 6 or more of 10 years of spring freeze and the same probability of extreme low winter temperatures.

6. Areas subject to frequent occurrence of fog during blossom period.

Interpretation of the Map

In arriving at a fruit site rating, it is assumed that modern soil and orchard management practices are to be applied. Special efforts are made not to be influenced in a site evaluation of a particular parcel by effects of either a substantially higher or lower level of management than is the norm on a producing orchard now occupying such a site. Improvements in management practices will continue to affect production in the future, but these are not likely to change a site rating.

Modification of Hazards

Available weather data is useful in broad determinations of whether or not certain crops can be considered for an area. The microclimate influences that affect fruit set cannot be obtained from existing weather data.

The site rating was made on the basis of the "natural characteristics" of the site and not for the possibility of using artificial heating for freeze protection. The need for additional microweather information is recognized. Such information would permit refinement in estimating the size of cold air storage basins in relation to drainage areas. The fruit site inventory was developed by today's standards of plant selection for red tart cherry planting stock. It does not rule out the possibility of improved varieties through a plant selection program that may reduce the site requirements of today's planting stock. The use and interpretations of the site map will not eliminate the need for on-site study and investigation for individual tracts.

Colors used on the map indicate the relative degree of hazard that exists for producing red tart cherries. Some of these hazards can be controlled. Also, some sites colored yellow or red may be as productive as the green colored sites, if the limiting factors are corrected.

A minor air flow block may be removed by opening up wooded areas or even by removing undergrowth. Small ridges of earth may be flattened with little effort. A major block to air flow such as a large earth obstruction can require major engineering to remove. This may be advisable if the cost-return ratio is favorable.

Areas with favorable air drainage but too steep for orchard operations may be reclaimed by reshaping the slopes. Where steep slopes are remade to more gentle slopes to accommodate mechanized operations, problems of severe erosion, rapid runoff, reduced aeration and unbalanced plant nutrition in the exposed subsoil material can result. Very intensive soil management may be needed to overcome these difficulties.

Sites rated low because of low available water capacity may be made productive with irrigation and intensive fertilization. Small wet spots may be drained, but tile drainage of orchards sometimes requires increased maintenance because of clogging by fruit tree roots.

Advantage should be taken of land forms to minimize cold weather damage before introducing artificial heat.

HOW TO USE THE RED TART CHERRY SITE INVENTORY

Locating Areas

At the back of this report is an index map and the red tart cherry site inventory map consisting of many sheets. On the index map are rectangles numbered to correspond to the sheets of the site map so that the map for any area can be located easily. On each map the site boundaries are outlined. Ad hoc symbols appearing within site boundaries are explained in the legend sheet. Small islands of desirable red tart cherry sites may occur in the unmapped area. Generally, they are too small in size to be considered for commercial orchards.

Finding Information

Explanation of colors used, page 5.

Definition of terms used are given in the Appendix

Explanation of symbols given in the legend on back of Index to Maps.

Soil information for Charlevoix and Emmet Counties is available on request from the Soil Conservation Service Field Office in Boyne City, Michigan.

For selected readings on climate, refer to references given in the Appendix.

APPENDIX

To aid understanding and insure uniform interpretation, definintions or explanations are given here for some of the terms used in this report.

Conditions affecting the microclimate of a particular site can increase or decrease the hazard of frost, fog or other localized climate important to the production of fruit or other very sensitive crops. The following is an attempt to define items that must be recognized in evaluating fruit sites. These are things which the experienced grower unconsciously considers when looking at a potential orchard site. By experience, these items have been found to influence success or failure of orchards on various sites over many years.

Air Flowageway

This is assumed to be the same flowageway as used by water except that it may be modified by physical conditions that affect air movement but that may not hinder water flow.

Air Movement

The movement of air under calm (no wind) conditions is due to changes in temperatures of the air. Warm air moves upward because it is less dense (lighter) and when moving upward it expands and cools. Cooling causes the air to become more dense, making it descend. This movement by convection is a principle which orchardists attempt to use and manipulate to their advantage. Unlike water, air moving down a slope tends to pile up behind a barrier and may build up to several times the height of the barrier before flowing over it and on downslope. It is suggested that this buildup may be caused by the leading edge being forced upward as it mixes with upward moving air warmed by radiation from the top of the barrier. Surface drag caused by resistance to air flow over ground vegetation also influences the downward flow of colder air. Observations indicate that movement of air down an air flowageway is not at a steady rate, but tends to surge, then slow, then surge ahead again.

Airshed

For this application, it can be assumed that the airshed will be the same area as a watershed contributing to a common outlet or storage basin.

Air Storage Over Water

Air flowageways ending over water are more desirable than those ending over land. Water, having better head conductivity and greater heat storage than soil, warms the incoming cold air on contact with it causing that air to rise, thus making room for more cold air entering from the flowageway.

Coarse Fragments

Rock or mineral particles greater than 2.0 millimeters in diameter.

Fog Damage

This refers to periods of daytime fog that inhibit the pollination of blossoms or that can cause delay in application of sprays for control of diseases. These conditions may occur in small pockets or may be common to larger areas that are subject to marine influence.

Major Obstruction

A closed barrier or constriction in an air flowageway, which will require large expenditures of time and money to correct, is considered a major obstruction. Examples are: raised roadbed or buildings constructed across an air flowageway, or large earth ridges or even conifer swamps which slow cold air movement to lower elevations.

Minor Obstruction

A minor obstruction is a constriction of air flowageway which can be readily removed at relatively small cost. Examples are: trees or small earth ridges which impede air movement to lower elevations.

Microclimate

This refers to the climate of an area, usually small, over which weather conditions are substantially the same. Differences of soil, soil cover, elevation and other factors can be responsible for significant variation in microclimate in areas only a few yards to a few hundred feet apart.

Pan

Horizon or layer in soils that is strongly compacted, cemented or very high in clay content.

Principle Spring Freeze Line

The principle spring freeze line is a locally determined elevation line which separates favorable from unfavorable spring temperatures for red tart cherry production. The frequency of severity of loss decreases with an increase of elevation above the principle spring freeze line.

Soil Drainage

As a natural condition of the soil, soil drainage refers to the condition of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil.

Spring Damage

This refers to partial or complete kill of fruit due to below freezing temperatures occurring from the time of spring bud swell to 14 to 18 days after bloom. It may also include poor pollination and fruit set because of cloudy days, rain or fog during blossom time.

Storage Basin

The lowest area to which air drains of its own free flow.

Minor Storage Basin

The area in which air may be held until sufficient fill takes place for overspillage to a major basin.

Size of Storage Basin

No definite criteria are available to say how large a storage basin should be for a definite drainage area. The larger the drainage area, the greater the size of the storage basin needed. It should be of sufficient size to permit the storage of cold air until daylight hours and accompanying warming.

Winter Temperature Injury

This refers to injury to fruiting buds and wood caused by temperature extremes or rapid fluctuation.

1. Wood injury associated with immaturity - early winter.

2. Injury associated with drought (long period of extremely cold air) - midwinter.

3. Injury to wood and bark due to an extremely fast drop in temperature (moderate winter temperature to very frigid temperature) - midwinter.

4. Injuries characteristic of late winter conditions.

Injuries such as trunk splitting that cause major damage to the structure of a tree received a zero rating for red tart cherries.

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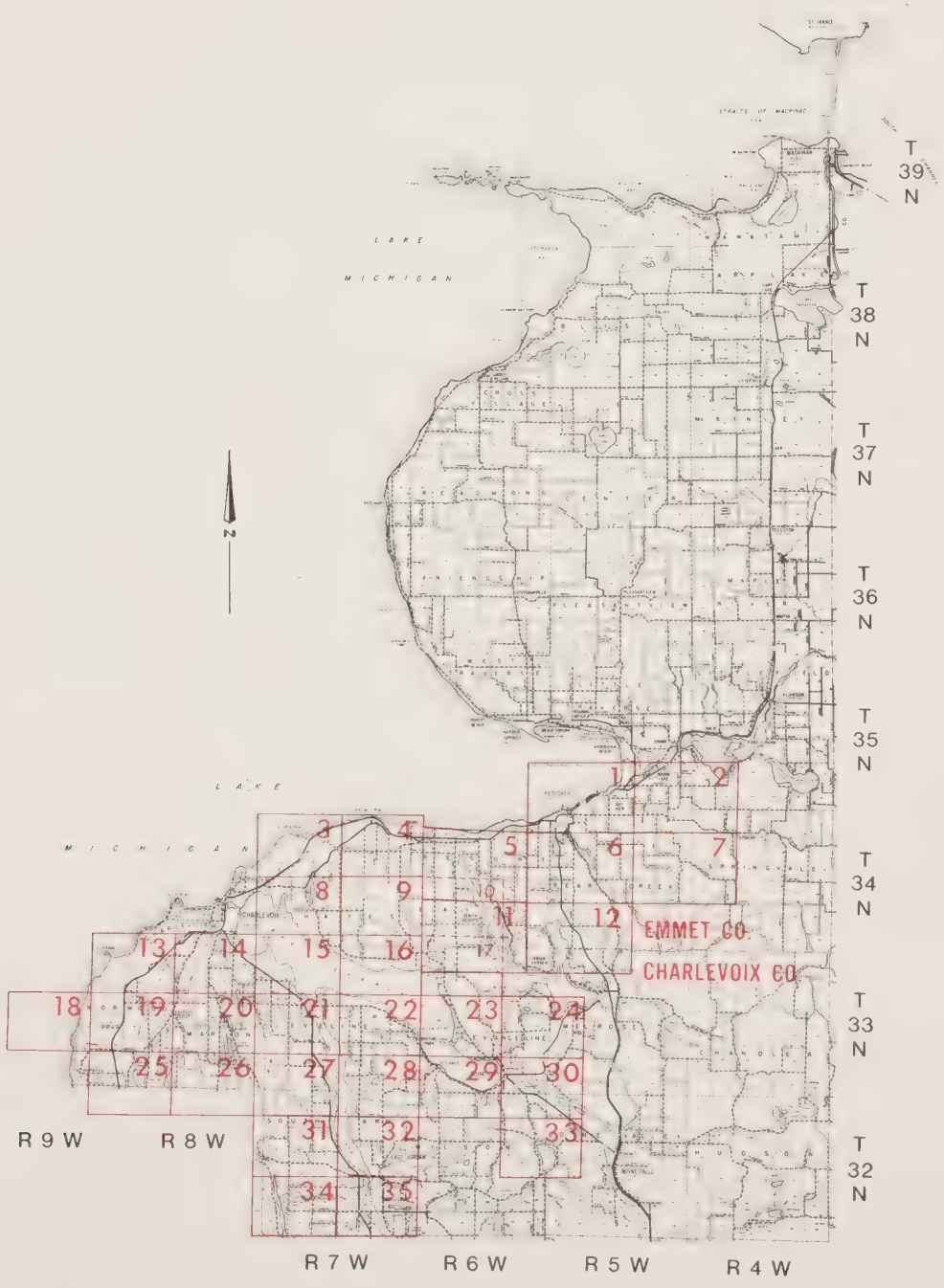
RED TART CHERRY SITE INVENTORY

CHARLEVOIX AND EMMET COUNTIES
MICHIGAN

INDEX TO MAP SHEETS



Photobase prepared from 1965 aerial photography. The photo image may vary from true ground location due to inherent aerial photographic displacement.

Source:
USDA aerial photography and information from field personnel

USDA-SCS-LINCOLN, NEBR. 1979

CHARLEVOIX AND EMMET COUNTIES
MICHIGAN

CONVENTIONAL SIGNS

INTERPRETATIONS FOR FRUIT SITE RATING

TOTAL SCORE	MAP COLOR	DIFFICULTY OF OVERCOMING LIMITATIONS TO PRODUCTION
300-290		SLIGHT
285-225		MODERATE
220-170		SEVERE
165 OR LESS		VERY SEVERE

AD HOC SYMBOLS

Physiographic features cause lower temperatures during critical blossom period	⊥
Concave surface causing slow air movement	U
Major block to downward air movement	Δ
Soils with special limitations	S
Topographic features with many depressions that collect and hold cold air. Also known as pitted topography or kettles.	K

LEGEND

COUNTY BOUNDARY	
SECTION LINE CORNERS	
SECTION NUMBERS	24
MINOR CIVIL DIVISION BOUNDARY	
STATE FOREST BOUNDARY	
DRAINAGE	
U.S. HIGHWAY	
STATE HIGHWAY	
ROAD	
RAILROAD	

695 000 FEET

INSET A

675 000 FEET

1 410 000 FEET

LAKE MICHIGAN

6 RESORT 5

(Joins sheet 5)

R. 6 W.

680 000 FEET

T. 34 N.

(Joins inset, sheet 11)

1 420 000 FEET

INSET B

685 000 FEET

1 411 000 FEET

LAKE MICHIGAN

RESORT 2

3

31

T. 34 N.

(Joins lower left)

R. 6 W.

690 000 FEET

(Joins sheet 5)

LAKE MICHIGAN

27

131

28

ELEV 580'

Spring Lake

31

B A Y

Bay View

34

33

(Joins sheet 2)

L I T T L E T R A V E R S E

32

Bear Creek

BEAR CREEK

31

PETOSKEY

5

4

T. 34 N.

T. 35 N.

(Joins inset B)

R E S O R T

1

R. 6 W.

R. 5 W.

(Joins sheet 6)

715 000 FEET

1 410 000 FEET

1

N

1 MILE

1 KILOMETER

0

0

1/4

0.5

1/2

3/4

Scale 1:20000

2

N

R. 5 W. | R. 4 W.

740 000 FEET

1 425 000 FEET

ROUND LAKE

ELEV. 599'

CROOKED LAKE

ELEV. 595'

Mud Lake

SPRINGVALE

B E A R C R E E K

Tannery Creek

Minnehaha Creek

Silver Creek

HARDWOOD STATE FOREST

T. 35 N.

T. 34 N.

1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 0.5 1/2 3/4

(Joins sheet 1)

(Joins sheet 7)

1 440 000 FEET

720 000 FEET

FOREST BOUNDARY

3

N

1 MILE

1 KILOMETER

Scale 1 15 840

0 0 1/4 0.5 1/2 3/4

650 000 FEET

1 410 000 FEET

ELEV. 580'

LAKE MICHIGAN

Big Rock Point

4

31

9

8

7

Burgess

Creek

S

S

S

(Joins sheet 4)

T. 34 N.

18

17

16

13

31

Susan

CHARLEVOIX

HAYES

Susan Lake

Mud Lake

635 000 FEET

R. 8 W.

R. 7 W.

(Joins sheet 8)

655 000 FEET

Ninemile Point

LAKE MICHIGAN

ELEV. 580'

LAKE MICHIGAN

31

31

Bayshore

T. 34 N.

H A T T Y E S

S

S

S

S

S

S

1

2

3

10

11

12

13

14

15

Horton Creek

EMMET CO.

(Joins sheet 3)

(Joins sheet 11)

R. 7 W.

(Joins sheet 9)

670 000 FEET

4

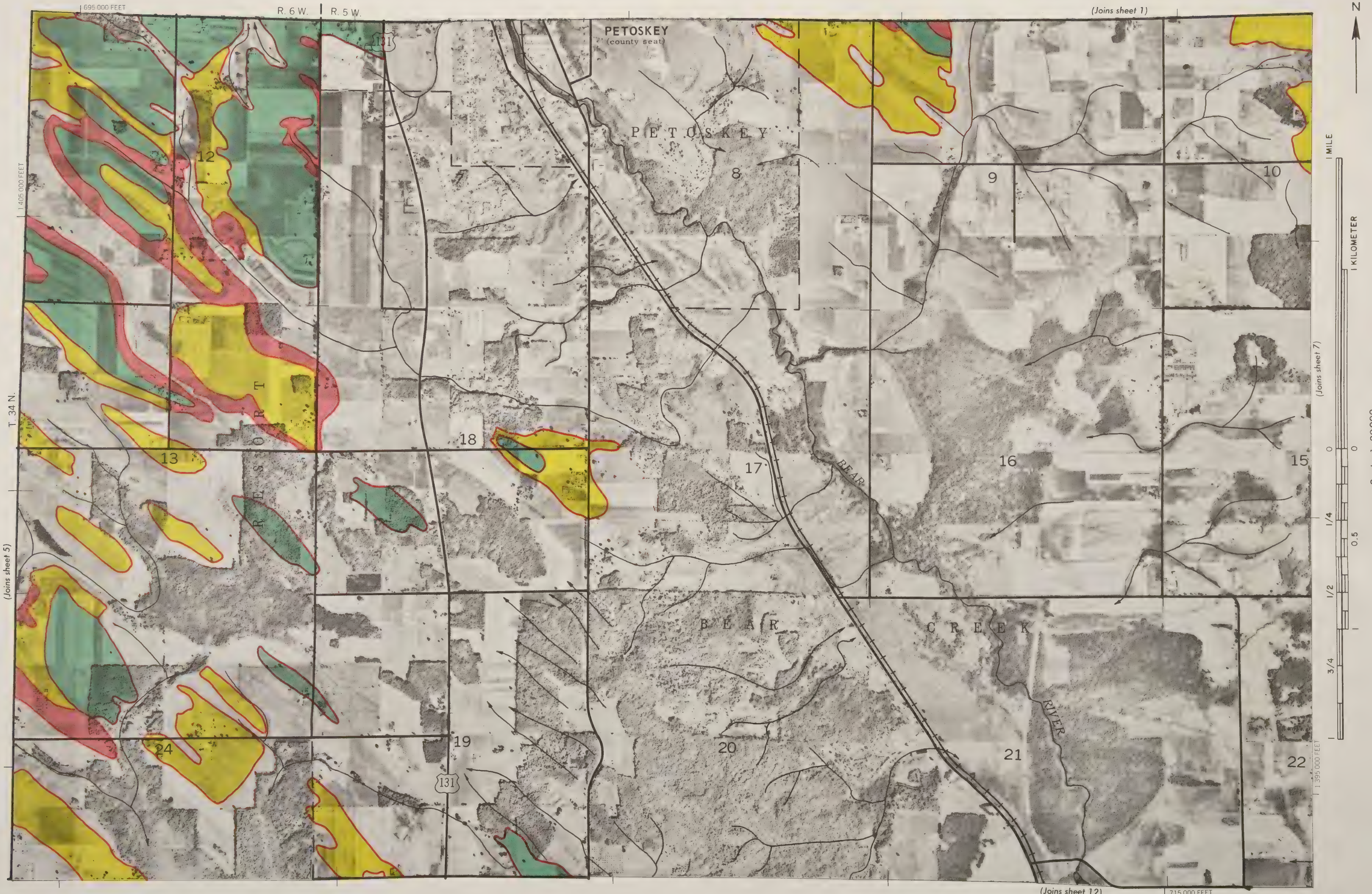
N

1 MILE

1 KILOMETER

Scale 1:15 840

N
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
1
Scale 1:20000
(Joins inset A, sheet 1)
R 6 W
LAKE MICHIGAN
(Joins inset B, sheet 1)
690 000 FEET
31
7
8
9
10
R E S O R T
W A L L O O N
L A K E
16
17
18
15
14
21
22
23
CHARLEVOIX COUNTY
ELEV.
687'
T. 34 N.
(Joins inset, sheet 11)
(Joins sheet 6)
(Joins sheet 11)
675 000 FEET
1 395 000 FEET



695 000 FEET
R. 6 W.
R. 5 W.
(Joins sheet 1)
PETOSKEY
(county seat)
PETOSKEY
RESORT
BEAR CREEK
BEAR
RIVER
T. 34 N.
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 12)
1 405 000 FEET
1 395 000 FEET
715 000 FEET
131
8
9
10
12
13
15
16
17
18
19
20
21
22
24
N
1 MILE
1 KILOMETER
Scale 1:20000

7

N

(Joins sheet 2)

R. 5 W. | R. 4 W.

740 000 FEET

1 MILE

1 KILOMETER

Scale 1:20000 (Joins sheet 6)

0 0 0.5 1/4 1/2 3/4 1

10 11 12 7 8

14 18 17

15 18

BEAR CREEK

SPRINGVALE

HARDWOOD STATE FOREST

West Branch Minnehaha Creek

BOUNDARY

FOREST

Minnehaha Creek

T. 34 N.

1 405 000 FEET

22 23 24 19 20

1 396 000 FEET

720 000 FEET

8

N

MILE

KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

R. 8 W. R. 7 W.

(Joins sheet 3)

650 000 FEET

1 395 000 FEET

T. 34 N.

(Joins sheet 9)

(Joins sheet 15)

635 000 FEET

CHARLEVOIX

31

31

24

19

20

21

ELEV. 674'

Mud Lake

Susan Lake

OYSTER BAY

H A Y E S

30

29

28

32

33

Woods Creek

LAKE CHARLEVOIX

ELEV. 580'

S

U

S

T

T


655 000 FEET
(Joins sheet 4)
R. 7 W.
R. 6 W.
EMMET CO.
N
U S
U S
22
23
24
19
Horton
T. 34 N.
H A Y E S
S
27
26
25
30
Creek
B A Y
(Joins sheet 8)
(Joins sheet 10)
S
34
35
36
31
(Joins sheet 16)
670 000 FEET
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840


N
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
EMMET CO.
R. 6 W.
685 000 FEET
1 395 000 FEET
T. 34 N.
(Joins sheet 9)
(Joins sheet 17)
675 000 FEET
19
20
21
W A L L O O N   L A K E
ELEV. 687'
S
B A Y
29
30
28
27
Zenith Heights
EMMET COUNTY
31
32
33
34


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:20000
R. 6 W.
670 000 FEET
water
(Joins inset A, sheet 35)
(Joins sheet 5)
1 410 000 FEET
7
31
Bayshore
CHARLEVOIX COUNTY
RESORT
T. 34 N.
18
1 400 000 FEET
668 000 FEET
CHARLEVOIX COUNTY
1 380 000 FEET
675 000 FEET
R. 6 W.
690 000 FEET
(Joins sheet 5)
27
26
1 390 000 FEET
WALLOON LAKE
CHARLEVOIX COUNTY
RESORT
35
(Joins sheet 12)
T. 34 N.
T. 33 N.
2
ELEV 687'


R. 6 W.
R. 5 W.
695 000 FEET
(Joins sheet 6)
N
1 390 000 FEET
(Joins sheet 11)
T. 34 N.
T. 33 N.
B E A R C R E E K
BEAR RIVER
W A L L O O N L A K E
R E S O R T
CHARLEVOIX COUNTY
ELEV. 687'
WALLOON LAKE
131
25
30
29
28
27
31
32
33
34
36
1
6
7
12
1 380 000 FEET
715 000 FEET
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000

600 000 FEET

1 385 000 FEET

LAKE MICHIGAN

ELEV. 580'

C H A R L E V O I X

32

31

PIGEON RIVER

STATE FOREST

STATE FOREST BOUNDARY

T. 34 N.

T. 33 N.

McGeach

Creek

Inwood

Creek

6

5

1

12

11

7

8

N O R W O O D

31

S

S

S

S

S

S

Inwood Creek

31

STATE FOREST BOUNDARY

R. 9 W. | R. 8 W.

(Joins sheet 19)

615 000 FEET

(Joins sheet 14)

13

N

1 MILE

1 KILOMETER

0 1/4 1/2 3/4 1

0 0.5 1

1 375 000 FEET

Scale 1:15 840

(14)

N
MILE
0
1/4
1/2
3/4
1
KILOMETER
0
0.5
1
Scale 1:15 840
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)
R. 8 W.
630 000 FEET
620 000 FEET
T. 34 N.
T. 33 N.
31
66
33
34
35
4
3
2
1
9
10
11
12
C H A R L E V O I X
M A R I O N
LAKE CHARLEVOIX
ELEV. 580'
Strover Creek
Loeb Creek
S
U


15
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 14)
(Joins sheet 21)
CHARLEVOIX
T. 34 N.
T. 33 N.
Twomile Point
LAKE
CHARLEVOIX
Evergreen Point
ELEV. 580'
EVELINE
MARION
HAYES
32
33
4
1
6
12
7
8
9
66
66
S
S
S
R. 8 W.
R. 7 W.
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
Scale 1:15 840

16

N

1 MILE

1 KILOMETER

0 0 1/4 0.5 1/2 3/4

Scale 1:15 840

(Joins sheet 9)

(Joins sheet 15)

670 000 FEET

1 385 000 FEET

34 35 36 31

T. 33 N. T. 34 N.

H A Y S

B A Y

Creek

1 2 6

ELEV. 580'

L A K E C H A R L E V O I X

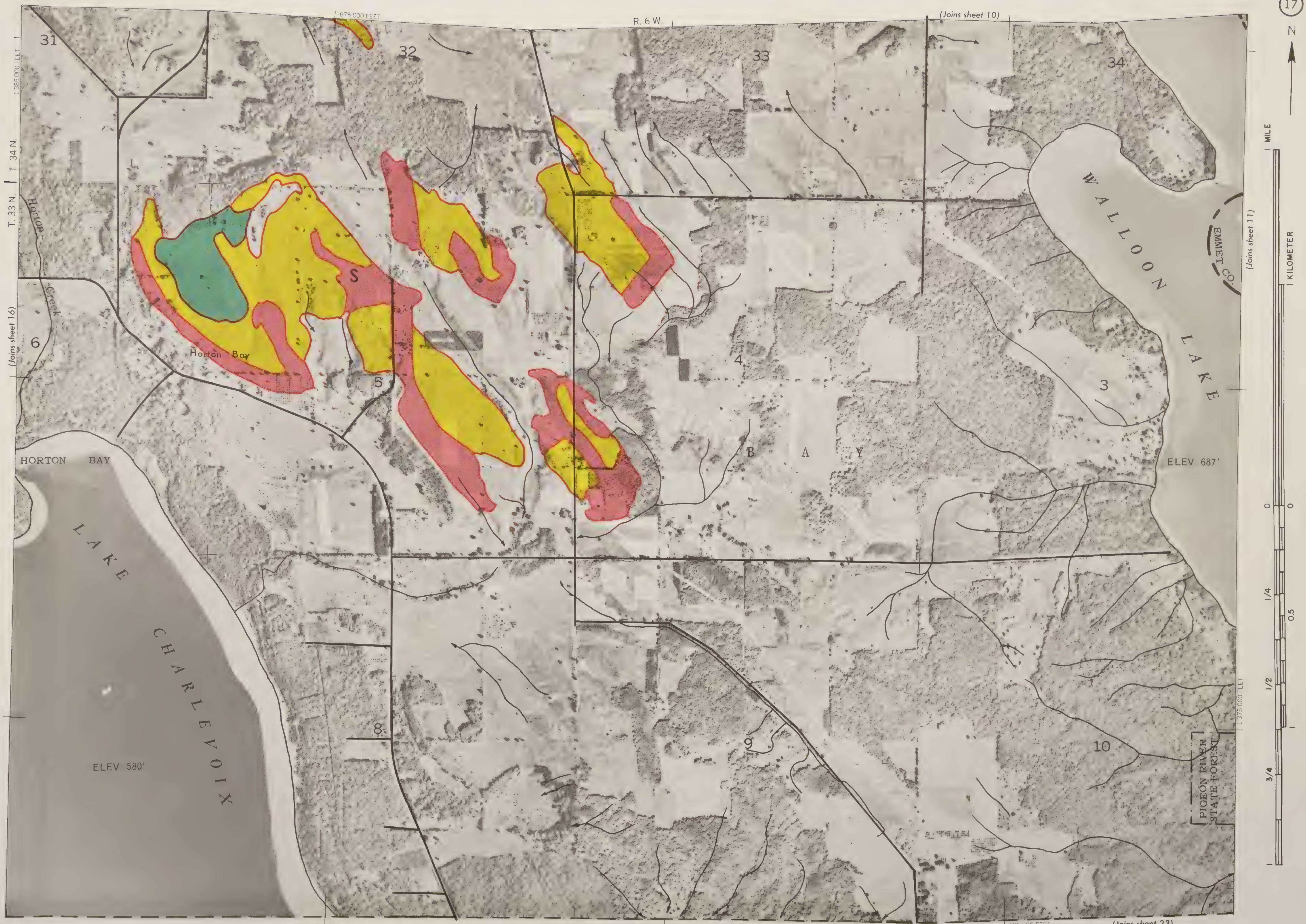
E V E L I N E

(Joins sheet 17)

(Joins sheet 22)

655 000 FEET

R. 7 W. R. 6 W.


N
R. 6 W.
675 000 FEET
(Joins sheet 10)
T. 34 N.
T. 33 N.
1 385 000 FEET
(Joins sheet 16)
(Joins sheet 11)
(Joins sheet 23)
685 000 FEET
1 375 000 FEET
31
32
33
34
6
5
4
3
8
9
10
S
Horton Creek
Horton Bay
HORTON BAY
LAKE CHARLEVOIX
ELEV 580'
WALLOON LAKE
ELEV. 687'
BAY
EMMET CO.
PIGEON RIVER STATE FOREST
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

N

18

Scale 1:15 840

1 360 000 FEET

580 000 FEET

1 359 000 FEET

592 000 FEET

R. 9 W.
R. 8 W.
(Joins sheet 13)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 25)
T. 33 N.
PIGEON RIVER
STATE FOREST
N O R W O O D
M A N I
Whiskey
Creek
Inwood
Barnard Creek
Barnard
Barnard Pond
31
13
14
17
18
19
20
23
24
25
26
29
30
615 000 FEET
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

20

N

(Joins sheet 14)

R. 8 W.

630 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

1 360 000 FEET

(Joins sheet 19)

Sitkum Creek

Adam's Lake

16

15

14

13

Barnard

S

M A R I O N

ELEV. 733'

ELEV. 723'

Twin Lakes

T. 33 N.

21

22

23

24

(Joins sheet 21)

Lake Marion

ELEV. 733'

28

27

26

25

Skinner Creek

(Joins sheet 26)

620 000 FEET

(Joins sheet 15)
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 27)
R. 8 W.
R. 7 W.
T. 33 N.
635 000 FEET
650 000 FEET
360 000 FEET
66
Ironton
SOUTH ARM LAKE CHARLEVOIX
E V E L I N E
M A R I O N
Knowland Lake
ELEV. 699'
ELEV. 580'
Holy Island
13
18
17
16
24
19
20
21
25
30
29
28
S
U
N
MILE
KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

22

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 0.5 1/4 1/2 3/4

(Joins sheet 16)

R. 7 W. | R. 6 W.

670 000 FEET

EVANGELINE

LAKE CHARLEVOIX

ELEV. 580'

15

14

13

water

S

E V E L I N E

22

23

24

19

T

U

S

Dyer Lake

Hayden Point

(Joins sheet 23)

1 397 000 FEET

T. 33 N.

(Joins sheet 21)

1 398 000 FEET

SOUTH ARM LAKE CHARLEVOIX

ELEV. 580'

27

26

25

30

WHITING PARK

(Joins sheet 28)

655 000 FEET


(Joins sheet 17)
675 000 FEET
R. 6 W.
1 370 000 FEET
T. 33 N.
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 29)
685 000 FEET
360 000 FEET
LAKE CHARLEVOIX
ELEV. 580'
Horse Point
EVELINE
EVANGELINE
YOUNG STATE PARK
STATE PARK BOUNDARY
Reservoir
BOYNE CITY
17
16
15
20
21
22
27
28
30
N
MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

24

N

1 MILE

1 KILOMETER

0 0 0.5 1/4 1/2 3/4 1

Scale 1:15 840

(Joins sheet 23)

STATE FOREST BOUNDARY

R. 6 W. R. 5 W.

705 000 FEET

WALLOON LAKE

ELEV. 687'

Mud Lake

14

13

18

17

75

E V A N G E L I N E

23

24

M E L R O S E

19

20

BOYNE CITY

26

25

30

29

75

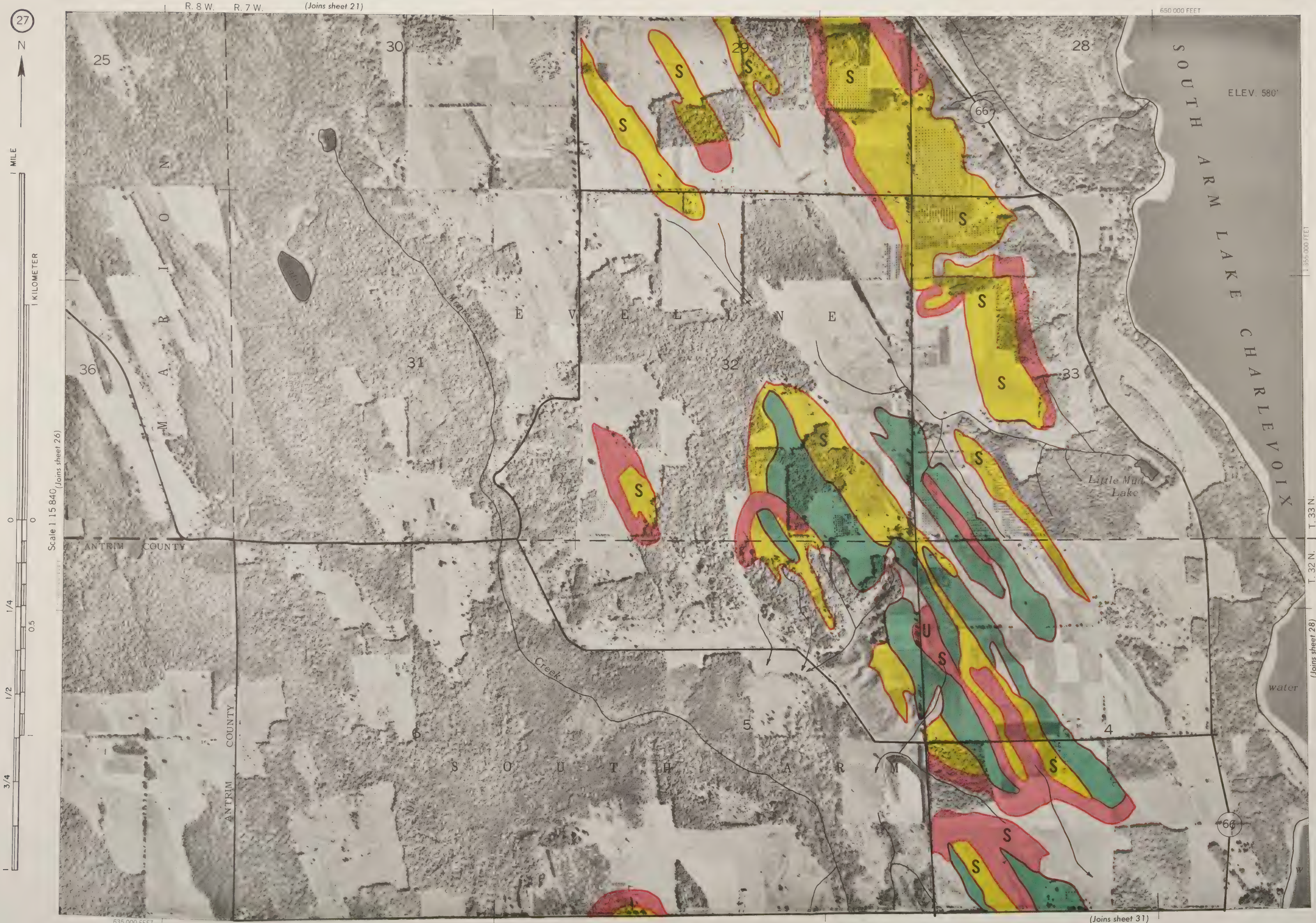
T. 33 N.

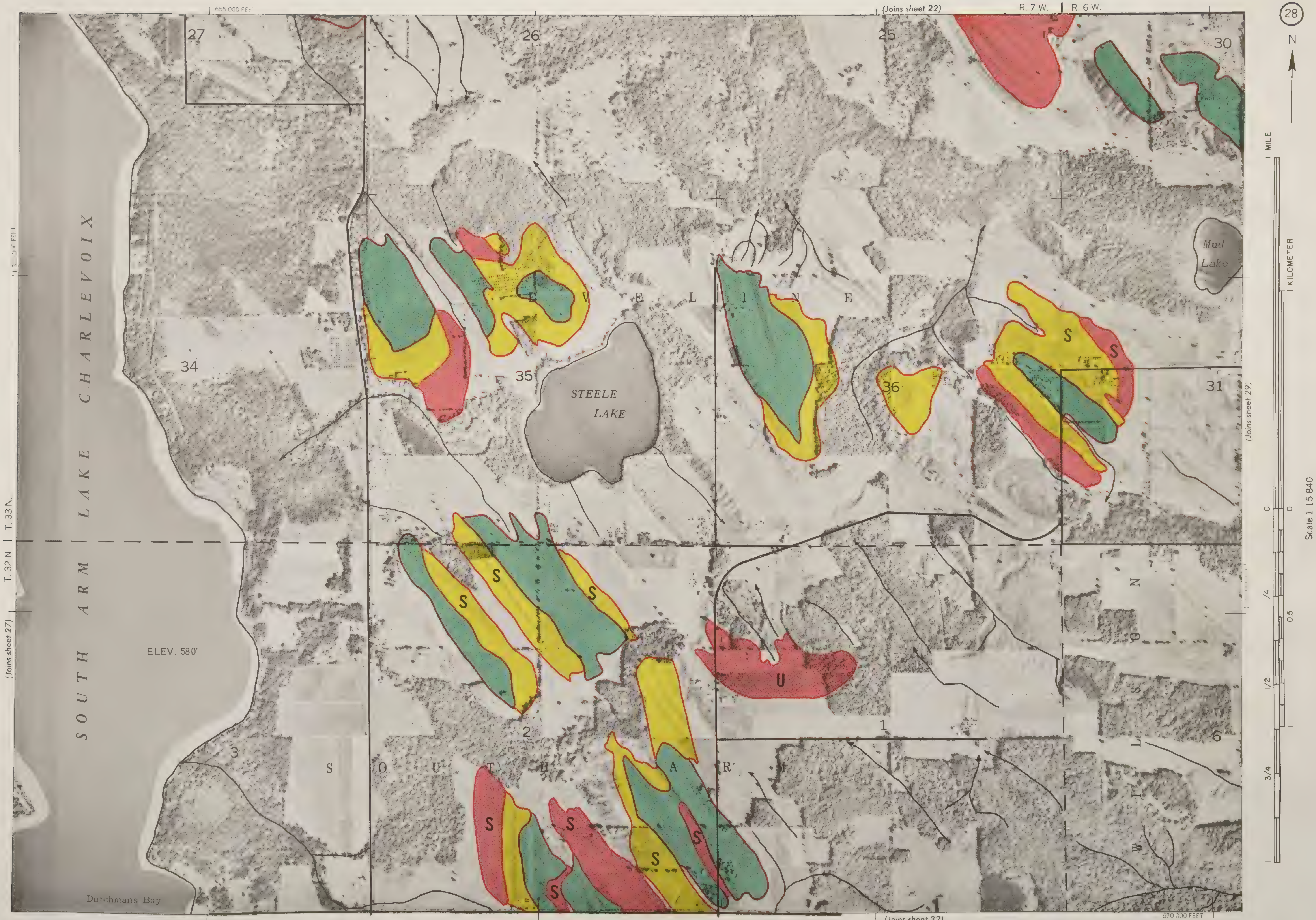
690 000 FEET

(Joins sheet 30)


(Joins sheet 19)
R. 9 W.
R. 8 W.
615 000 FEET
N
1 MILE
1 KILOMETER
0
0.5
1/4
1/2
3/4
Scale 1:15 840
(Joins inset, sheet 18)
N O R W O O D
M A R I O N
26
25
30
29
35
36
31
32
31
Harwood Lake
ELEV. 750'
Barnard Creek
Cunningham Lake
ELEV. 746'
Matchett Lake
ELEV. 749'
Mitchell Lake
T. 33 N.
1 355 000 FEET
(Joins sheet 26)
ANTRIM COUNTY
600 000 FEET

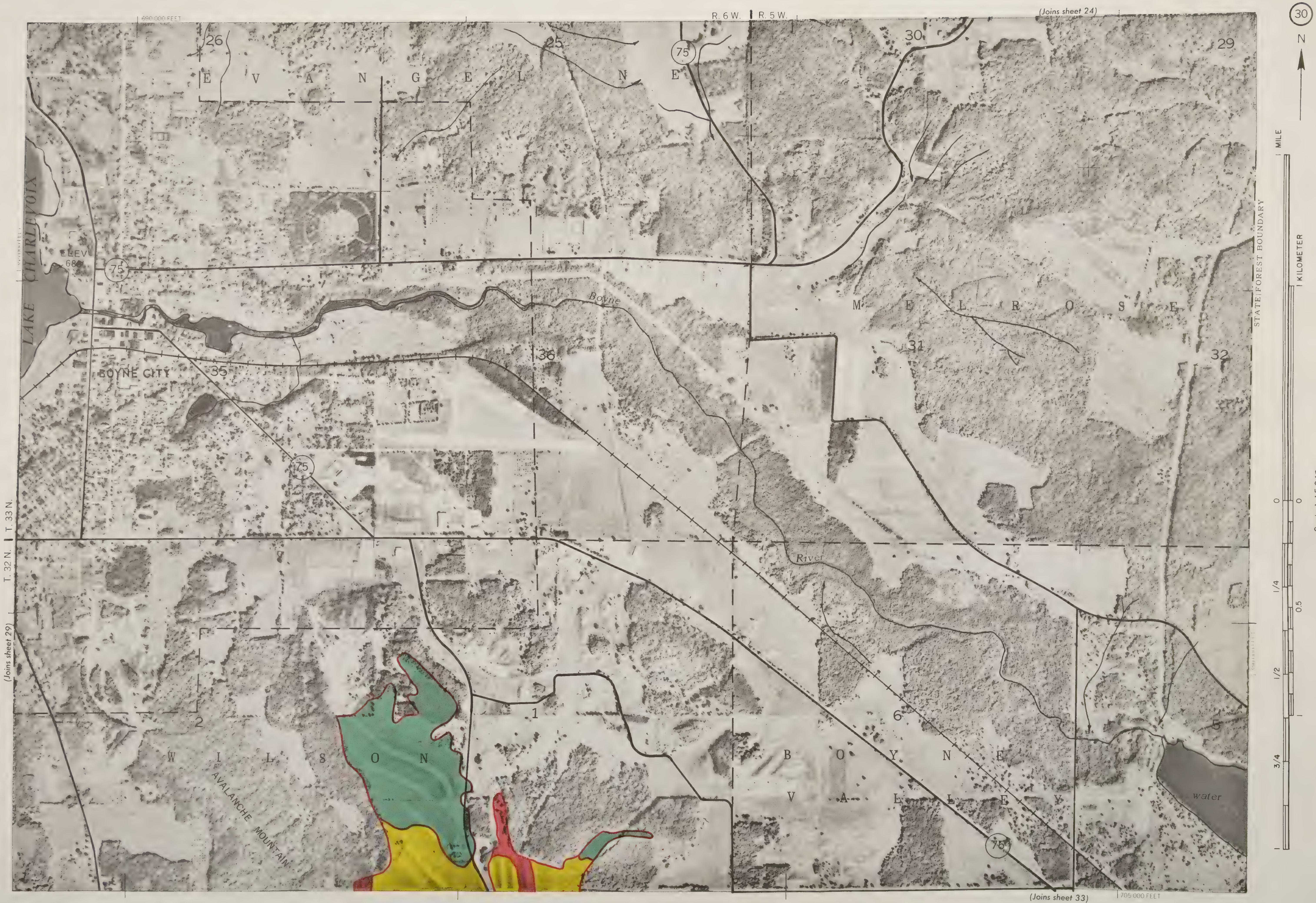

620 000 FEET
R. 8 W.
(Joins sheet 20)
N
28
27
26
25
Lake Marion
ELEV 733'
Skinner Lake
ELEV. 763'
Phelps
Skinner Creek
Mason Creek
Marion Creek
M A R I O N
T. 33 N.
33
34
35
36
S
(Joins sheet 25)
(Joins sheet 27)
ANTRIM COUNTY
630 000 FEET
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
Scale 1:15 840

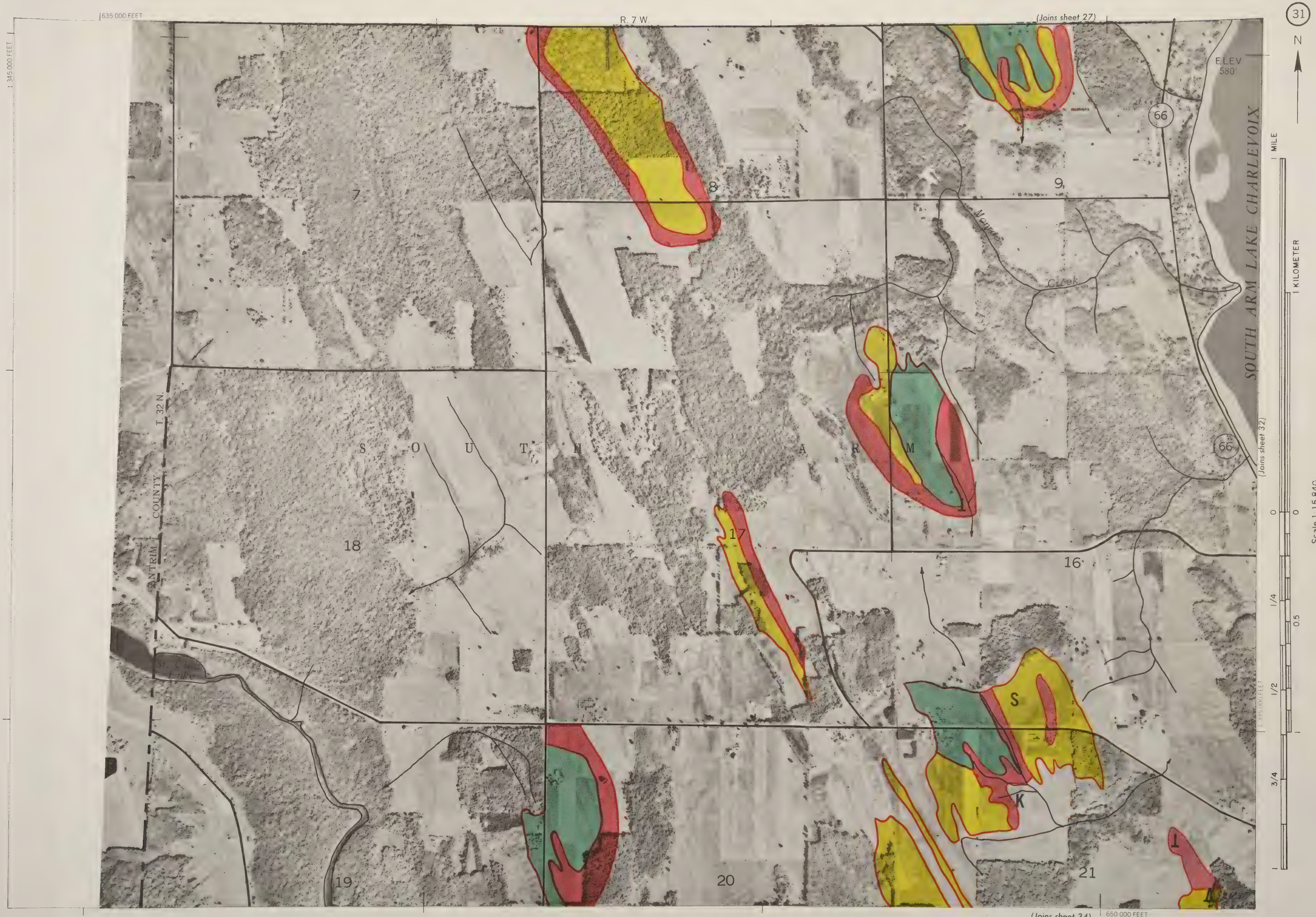

27
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
1
Scale 1:15 840
(Joins sheet 26)
R. 8 W.
R. 7 W.
(Joins sheet 21)
650 000 FEET
SOUTH ARM LAKE CHARLEVOIX
ELEV. 580'
66
Little Mud Lake
T. 33 N.
T. 32 N.
(Joins sheet 28)
water
(Joins sheet 31)
635 000 FEET
MARION
EVELINE
SOUTH ARM
ANTRIM COUNTY
Monroe
Creek
25
30
29
28
36
31
32
33
6
5
4
S
U


655 000 FEET
(Joins sheet 22)
R. 7 W.
R. 6 W.
27
26
25
30
N
MILE
KILOMETER
Mud Lake
E V E L I N E
34
35
STEELE LAKE
36
31
SOUTH ARM LAKE CHARLEVOIX
T. 33 N.
T. 32 N.
(Joins sheet 27)
(Joins sheet 29)
ELEV. 580'
S
U
2
1
3
6
S O U T H A R M
W I L S O N
Dutchmans Bay
(Joins sheet 32)
670 000 FEET
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

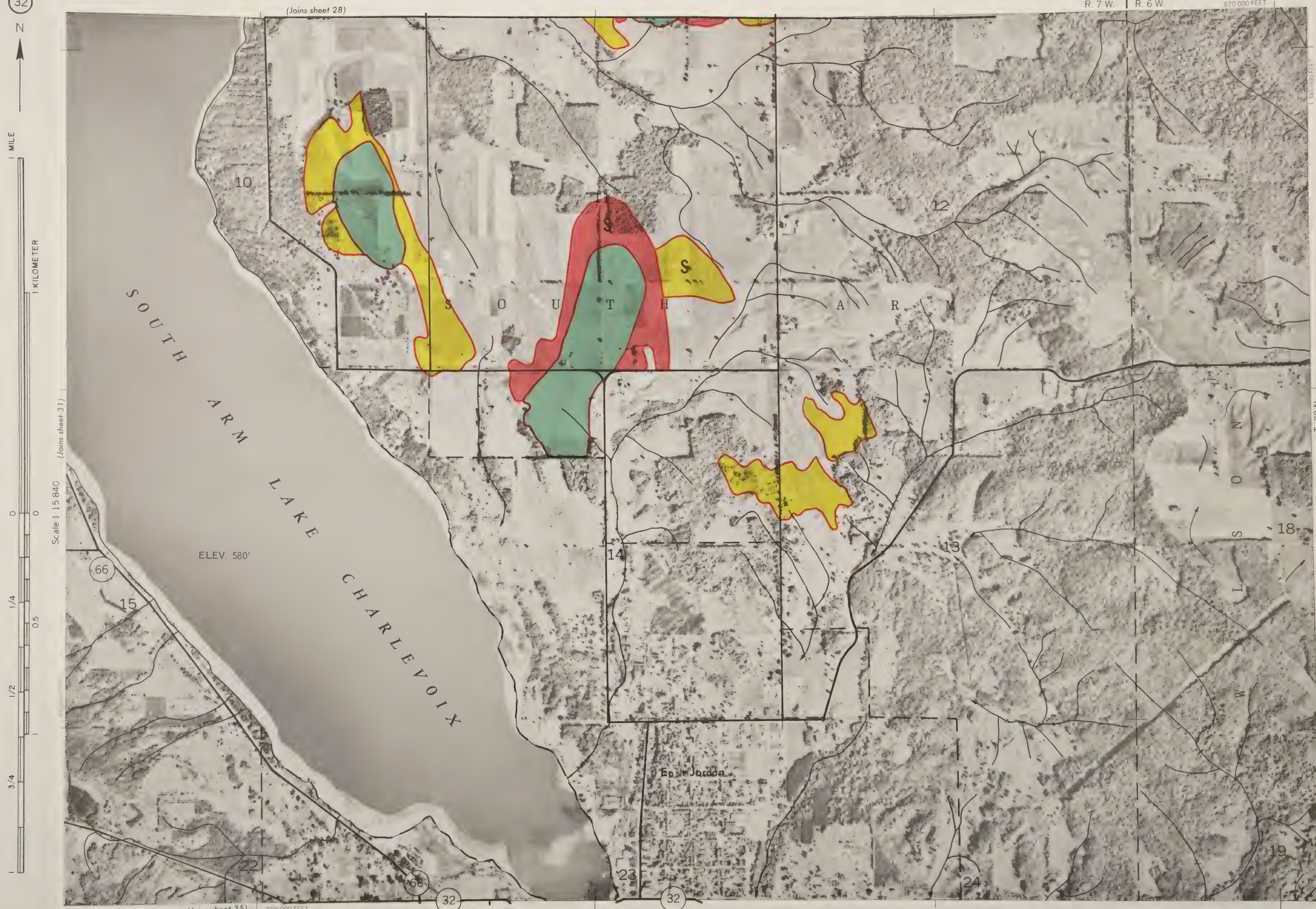
29

(Joins sheet 23)
R. 6 W.
685 000 FEET
BOYNE CITY
28
27
Anderson Point
30
29
Advance
LAKE
CHARLEVOIX
E V A N G E L I N E
31
32
E V E L I N E
Porter
Creek
ELEV. 580'
33
34
BOYNE CITY
T. 33 N.
T. 32 N.
6
5
4
3
W I L S O N
(Joins sheet 28)
(Joins sheet 30)
1 360 000 FEET
675 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1


(Joins sheet 24)
690 000 FEET
R. 6 W.
R. 5 W.
26
25
30
29
75
EVANGELINE
LAKE CHARLEVOIX
ELEV 680
Boyne
MELROSE
BOYNE CITY
35
36
31
32
STATE FOREST BOUNDARY
T. 33 N.
T. 32 N.
River
(Joins sheet 29)
2
1
6
5
WILSON
AVALANCHE MOUNTAIN
BOYNE
VALLEY
water
(Joins sheet 33)
705 000 FEET
N
MILE
KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840



31
635 000 FEET
1 345 000 FEET
R. 7 W.
(Joins sheet 27)
N
ELEV
580'
66
SOUTH ARM LAKE CHARLEVOIX
MILE
1 KILOMETER
(Joins sheet 32)
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
S O U T H A R M
7
8
9
16
17
18
19
20
21
Creek
T. 32 N.
ANTRIM COUNTY
S
K
M
(Joins sheet 34)
650 000 FEET


(Joins sheet 28)
R. 7 W.
R. 6 W.
670 000 FEET
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
Scale 1:15 840
(Joins sheet 31)
SOUTH ARM
SOUTH ARM LAKE CHARLEVOIX
ELEV. 580'
WILSON
T. 32 N.
S
S
10
12
13
14
15
18
19
22
23
24
66
32
East Jordan
(Joins sheet 35)
655 000 FEET

(33)

(Joins sheet 30)

R. 6 W.

R. 5 W.

705 000 FEET

1 345 000 FEET

N

MILE

KILOMETER

Scale 1:15 840

0 0

1/4 0.5

1/2

3/4 1

11

12

7

8

75

W I L S O N

Porter Water Creek

ELEV. 709'

B O Y N E

V A L L E Y

T. 32 N.

14

13

18

17

D E E R L A K E

STATE FOREST BOUNDARY

PIGEON RIVER STATE FOREST

19

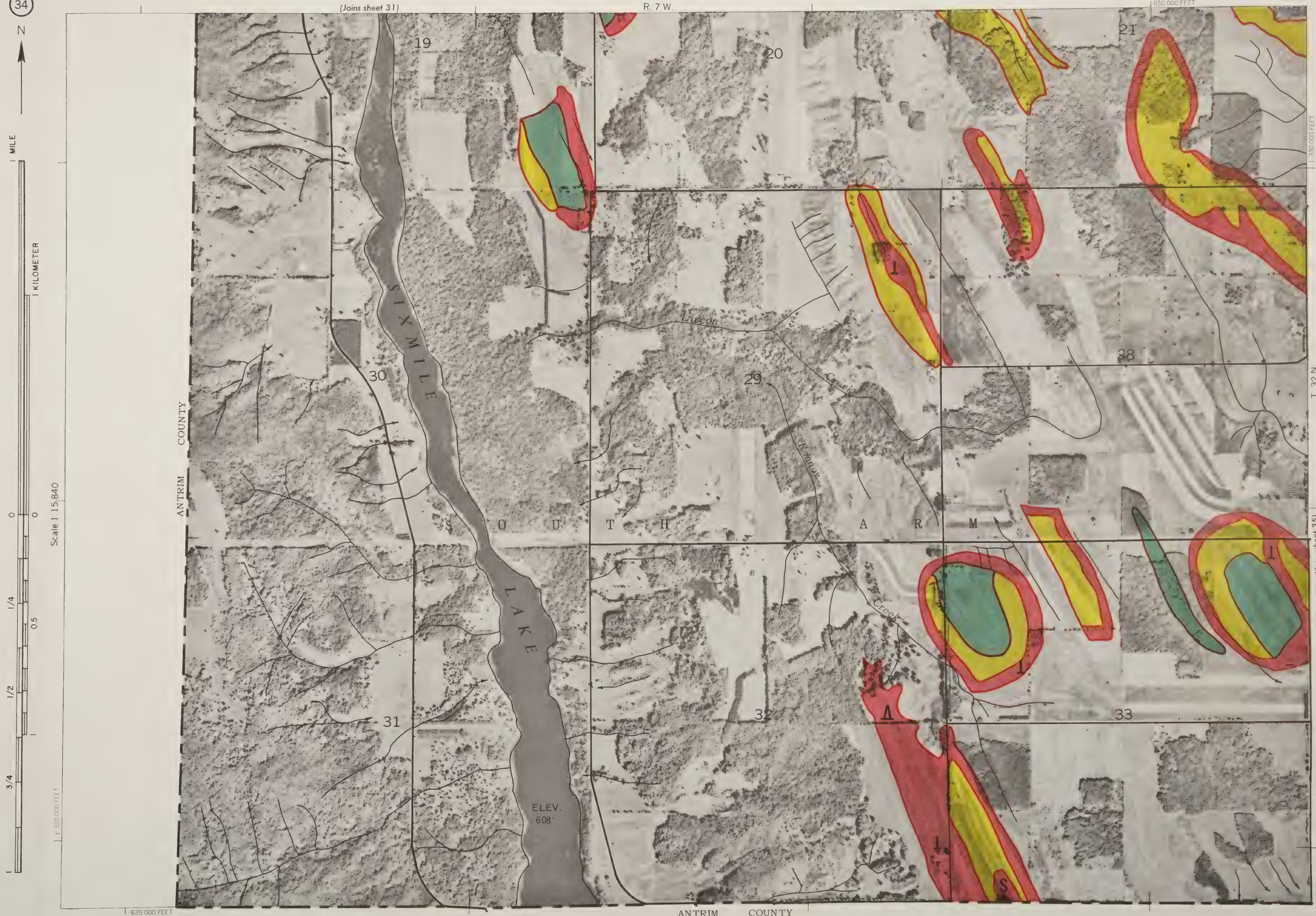
20

23

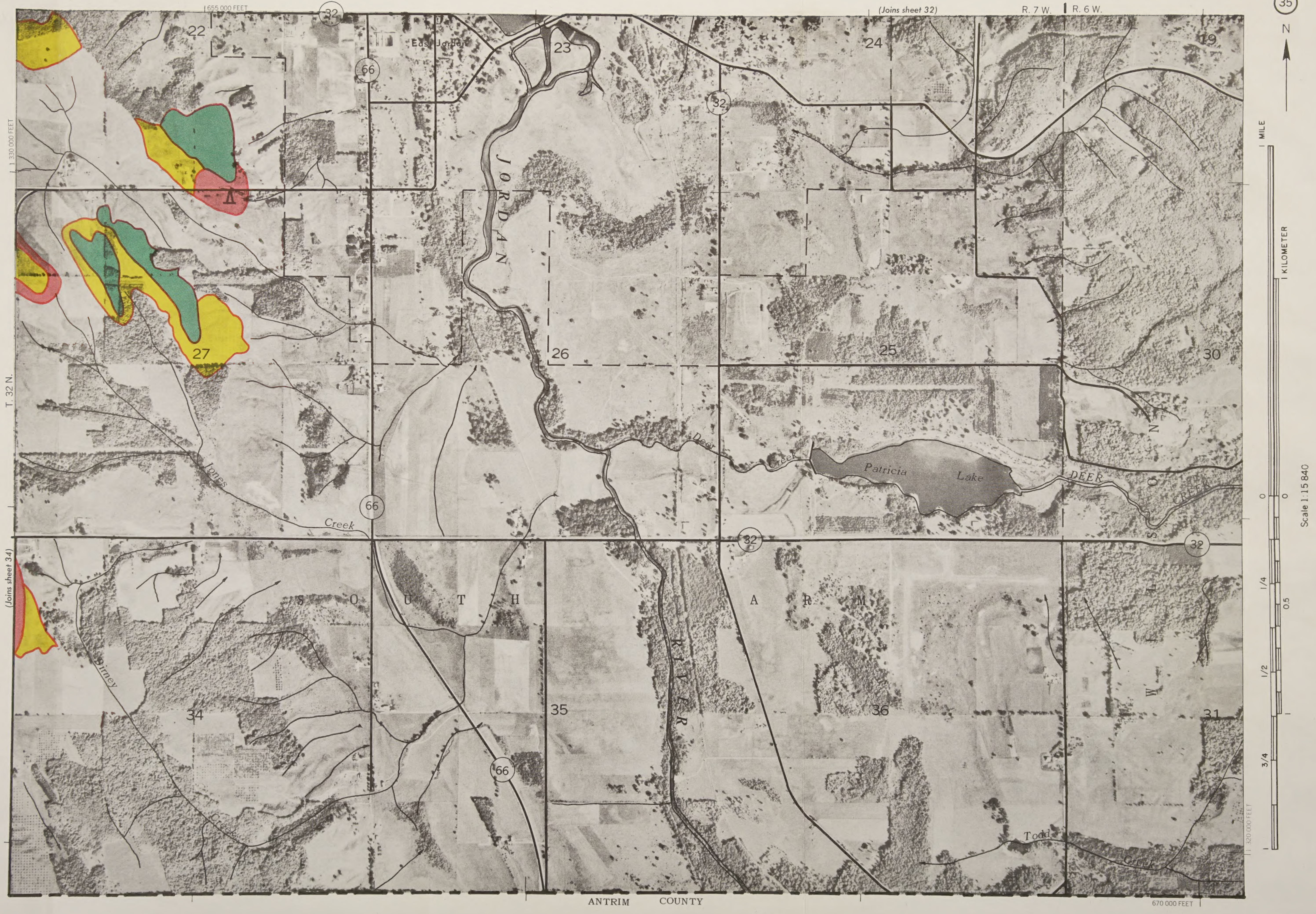
24

640 000 FEET

STATE FOREST BOUNDARY



(Joins sheet 31)
R. 7 W.
650 000 FEET
19
20
21
1 330 000 FEET
SIXMILE
LAKE
S O U T H A R M
30
29
28
T. 32 N.
(Joins sheet 35)
ANTRIM COUNTY
31
32
33
ELEV. 608'
635 000 FEET
1 320 000 FEET
ANTRIM COUNTY
Scale 1:15 840
N
MILE
KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1


655 000 FEET
(Joins sheet 32)
R. 7 W.
R. 6 W.
N
East Jordan
22
23
24
19
27
26
25
30
34
35
36
31
32
66
JORDAN
RIVER
Deer Creek
Patricia Lake
DEER CREEK
Jones Creek
Birney
Todd Creek
SOUTH ARM
T. 32 N.
330 000 FEET
(Joins sheet 34)
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840
320 000 FEET
670 000 FEET
ANTRIM COUNTY